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IN-SITU OBSERVATION OF D-RICH CARBONACEOUS MATTERS EMBEDDED IN NWA 801 CR2 CHONDRITE

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Introduction: Insoluble organic matter (IOM) extracted from carbonaceous chondrites is considered to have formed in cold molecular clouds and/or outer solar nebula, because of its enrichment of D and ^{15}N [e.g., 1]. However, occurrences of IOM in chondrite are poorly understood. This is because most of the previous studies for meteoritic organic matters used extracted-IOM. In this study, we observed organic matters in chondrite by in situ hydrogen isotopic analysis to reveal their morphologies and occurrences.

Methods: The sample used in this study is a polished thin section of NWA 801 CR2 chondrite. Hydrogen isotope imaging (isotopography) was performed by a Hokudai isotope microscope system (Cameca ims 1270 equipped with SCAPS) [2]. We obtained $^{1}H^{-}$, $^{2}D^{-}$, and $^{12}C^{-}$ images from 65 areas of ~50 μm in diameter in the NWA 801 matrix. Hydrogen isotopic composition of the matrix was normalized to a reported value of phyllosilicate of Renazzo CR2, which is estimated to be +730‰ [3]. Morphologies of carbonaceous matters identified by isotopography were observed by FE-SEM-EDS (JSM-7000F, Oxford INCA Energy) system.

Results and Discussion: D-rich spots with high C secondary ion signals were found in isotopography in the 33 areas of 65 areas. Total numbers of the D-rich carbonaceous spots were 84. δD values of the carbonaceous spots are ranged over 1700–9600‰. These carbonaceous spots are not distributed randomly in the NWA 801 matrix. We identified the morphologies of 48 D-rich carbonaceous spots. The other 36 spots have been failed to determine the locations by the SEM-EDS because of too small X-ray intensities of carbon. The 48 D-rich carbonaceous spots are composed of carbonaceous matters which morphologies are basically globular. Morphologies of the D-rich carbonaceous globules were classified into four groups; round globules, irregular-shaped globules, globule aggregates and ring globules. Round and irregular-shaped globules consist of a separated globule embedded in silicate matrix, which sizes distribute 0.2–1.0 μm. The globule aggregate consists of an aggregate of carbonaceous globules with silicates. The aggregate sizes are 0.3–2.6 μm. Ring globules are ring shaped carbonaceous globules with sizes of 0.3–0.8 μm that include silicate or void in their interior. The ring globules including a void are similar in morphology to organic globules observed in Tagish Lake meteorite [4]. Numbers of Round globules, Irregular-shaped globules, Globule aggregates and Ring globules are 6, 9, 26, and 7 respectively.

The carbonaceous matters with H isotope anomaly found in this study are mainly composed of H and C, and are enriched in D. These characteristics indicate that these matters correspond to organic matters formed in molecular clouds and/or outer solar nebula. Formation processes of these morphorogies can be explained by a formation model of organic matters in molecular clouds [e.g., 5].

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SOLAR WIND ABUNDANCES OF C AND O

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Introduction: Quantitative understanding of solar wind (SW) elemental fractionation is required to improve knowledge of the solar nebula abundances from Genesis samples, in particular abundances of volatile elements, depleted in CI chondrites. Ratios of elements with low and high first ionization potential (FIP) in the solar wind, e.g., Fe/He, are higher than photospheric abundances. C, O, and N have intermediate FIP and are thus critical as to whether this fractionation is stepwise or gradual as a function of FIP.

Analyses: Genesis solar wind O and C fluences are sufficiently high for precise SIMS analysis; however, surface contamination, mixed to depths as large as 50–100 nm, is a major problem. We adopted 3 mitigations: (1) conventional front side depth profiling with low energy Cs surface cleaning using the CalTech Cameca 7f, and backside depth profiling on a Genesis bulk solar wind sample thinned to 350 nm using (2) 7f, and (3) nanoSIMS. All three methods gave useful data with the most precise data from (2).

Results: The Figure inset shows the 7f C concentration measured versus distance from the backside of the thinned sample. The red portion of the curve is ion beam mixed surface contamination reaching instrumental background around 130 nm. Just prior to 200 nm, solar wind C is measured, rising to about 8 × background levels until contributions from epoxy binding the sample to a substrate terminate the analyses at 350 nm. Similar profiles were obtained with O. The non-inset part of the figure shows that the measured profile matches theoretical predictions. Interferometry showed that the maximum analysis depth was set by non-normal incidence of the ion beam with the sample surface. This effect is reduced with the 20 μm size of the nanoSIMS pits; however, no improvement in SW peak depth resolution was obtained, probably because of a greater amount of mixing at the sample-epoxy interface with the nanoSIMS than with the 7f.

Conclusions: Normalizing to Mg (low FIP element), the Genesis solar wind (C/Mg) and (O/Mg) ratios are 3.7 and 5.1 respectively, indicating a constant solar wind/photosphere depletion factor of about 0.38 despite the higher FIP for O (13.6 v 11.3 for C).